6th Newsletter, January 2021

LIFE-Respire

Radon r**E**al time monitoring **S**ystem and **P**roactive **I**ndoor **Re**mediation - LIFE16 ENV/IT/000553

[Website: www.liferespire.eu, www.liferespire.it](http://www.liferespire.eu)

The LIFE-RESPIRE (**R**adon r**E**al time monitoring **S**ystem and **P**roactive **I**ndoor **Re**mediation) project, which started in September 2017, is approaching the end of its first year. The project is realized with the financial contribution of the European Union LIFE programme (LIFE16 ENV/IT/000553).
The main objective of the project is **to demonstrate in 4 areas** (Caprarola, Celleno, and Ciampino in Italy and Jalhay in Belgium) characterised by different Geogenic Radon Potential (GRP), a cost-effective and eco-friendly solution for Rn real-time measurement and remediation **to keep indoor Rn levels below 300 Bq/m^3** (as indicated in European Directive 2013/59/EURATOM). The RESPIRE project will implement an intelligent, adaptable and versatile hybrid Rn remediation system composed of sensors, an Air Quality Balancer (SNAP) and an external additional fan-system (eolian and/or electric) working on positive pressure method. A control model based on a IoT protocol will be also implemented.

The LIFE-RESPIRE geodatabase, consisting of collected continuous and discrete Rn measurements coupled with other geological, geochemical and building characteristics data, will be linked to a WebGIS for easy data management, analysis and visualization by the consortium, and available to the local authorities for land use planning and health risk assessment, helping to prepare relevant national action plans (see Articles 54, 74 and 103 in 2013/59/EURATOM).

This newsletter highlights the main actions conducted in the 5th semester of the project and lists some of the dissemination activities at conferences. Some of the mentioned material is available to the public on the Document section of the LIFE-Respire website.

Any interest and collaboration with the LIFE-Respire Group is appreciated, please contact us!

More information about the purposes of the project can be found on the LIFE-RESPIRE website.

COMUNE DI CAPRAROLA

Comune di Celleno

CITTÀ DI CIAMPINO
CITTA' METROPOLITANA DI ROMA CAPITALE

LIFE-Respire Consortium

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CNR-IGAG: Institute of Environmental Geology and Geoengineering of the National Research Council, Rome, Italy

INGV: National Institute of Geophysics and Volcanology, Rome, Italy

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IN THIS ISSUE

1. Monitoring (Action B3)

The LIFE-Respire remediation system consists of two main components, the radon sensor with its associated control electronics and the ventilation unit for air exchange. Development work has continued on both aspects since our last newsletter, addressing both reliability and effectiveness.

The electronics part of the system has undergone various improvements in the last year, aided primarily by substituting an ad hoc electronic board with a low-cost Raspberry Pi mini-computer. This upgrade allowed us to use a well-tested, powerful framework on which to build new capabilities now and for future development. The present version has an internal data logger to prevent data loss if connectivity with the Cloud is temporarily lost, direct Wi-Fi communications to a local hotspot to give the system more flexibility, integrated pressure, temperature and humidity sensors to better monitor air quality, energy efficiency and radon exchange processes, and a more robust computer code (“firmware”) for managing the unit as a whole.

This new generation is presently being tested in 2 sites in Belgium and 2 sites in Italy, with many more ready for installation once the COVID pandemic situation improves and it is possible to access the other test homes and schools.

Although the project initially used an extraction fan for ventilation, it was always foreseen to test other types of technologies during LIFE-Respire. Over the last year we have been examining the potential of small heat-recovery and heat-exchange units, particularly in terms of addressing our goals of improving air quality while maintaining a reasonable level of energy efficiency. Heat-recovery units are lower cost but move less air, due to the fact that they have a bi-directional fan that alternates between air extraction and ingress to allow heat recovery via a ceramic disk. The more expensive heat-exchange units, instead, have higher flow rates because the exiting indoor air and the entering outside air are flowing constantly in separate pathways that allow for heat to be transferred. One test we conducted involved installing a heat-recovery unit in a room in a semi-basement, together with radon sensors in this and an adjacent control room. As can be seen in Figure 1, radon concentrations in the test room drop to about half of those in the control room once the ventilation unit is set to bi-direction air exchange. These results are highly promising for attaining the project’s goal of reducing average annual radon concentrations below the legislated level.

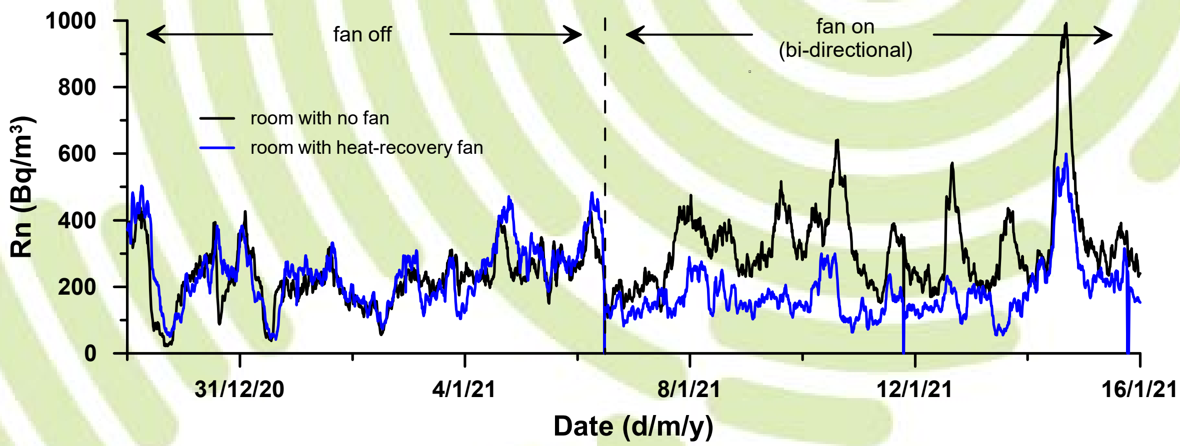

Figure 1. Radon concentrations in two adjacent rooms, one with and one without a heat-recovery unit. Note that for the period when the fan is off the concentrations are very similar, whereas once the fan is turned on the radon concentrations in the test room are significantly lower than those in the control room.

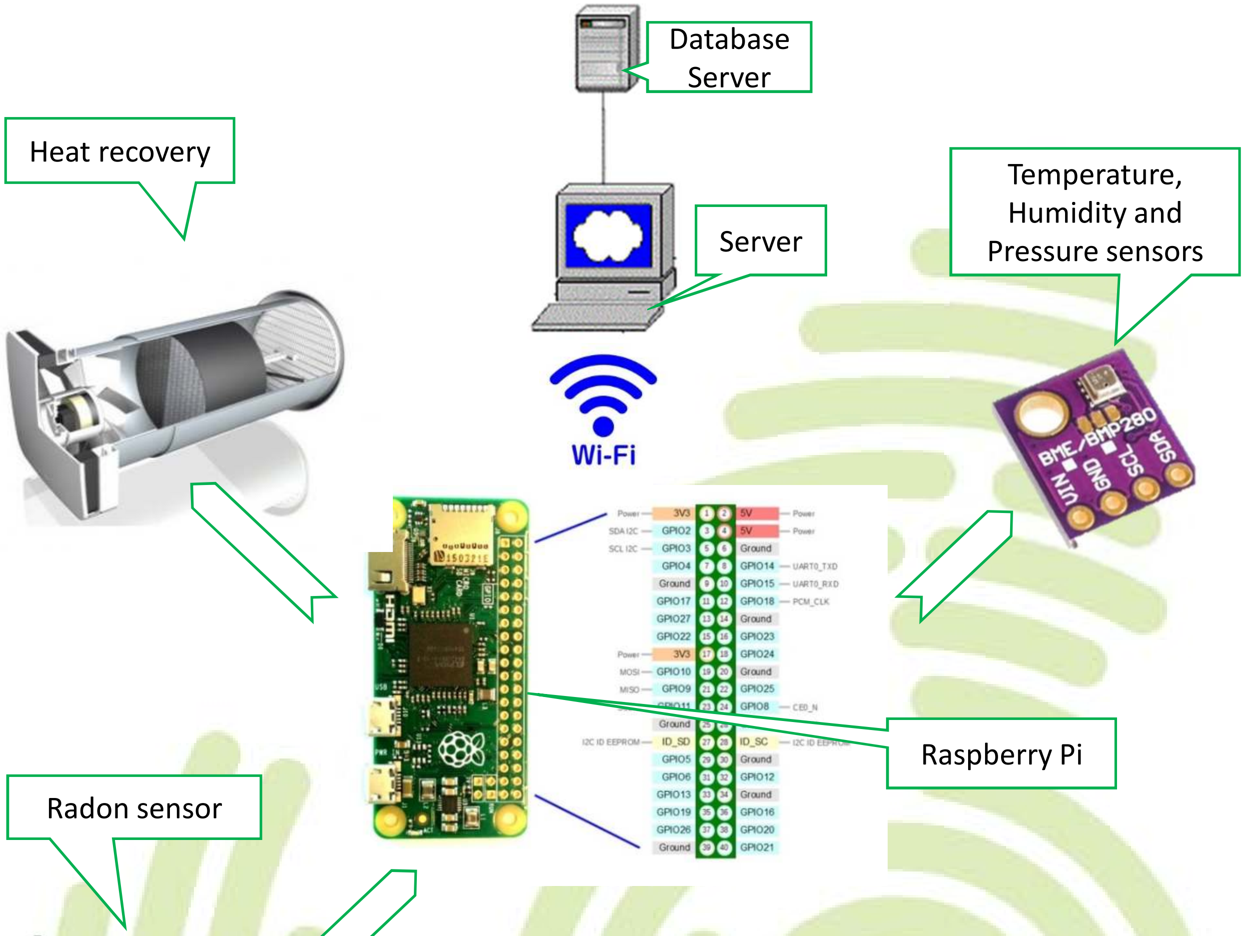

Figure 2. Scheme of the radon sensor with its associated control electronics.

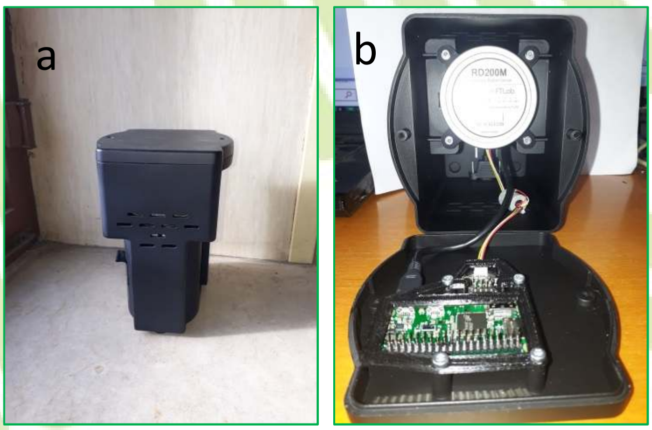

Figure 3. Photograph of the radon sensor: the external case (a), internal parts (b and c)

2. Replicability potential evaluation and demonstrative case in Belgium (Action B4)

The response time of the SNAP system was studied by moving a SNAP measurement device in and out a crawl space with high (~400 Bq/m³) radon concentration (Fig. 4).

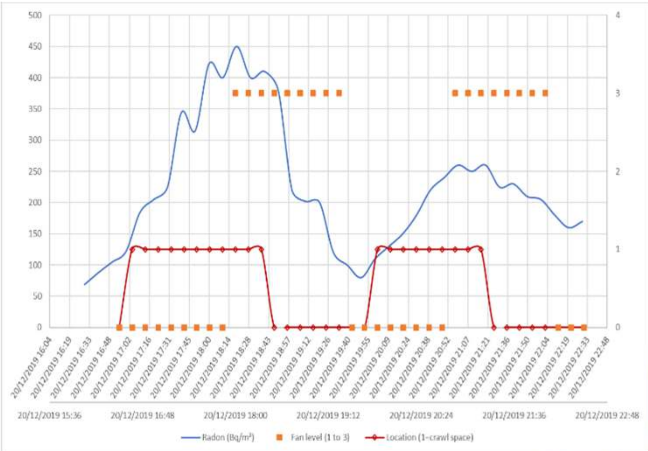

Figure 4. Response-time of the SNAP system in a – crawl space environment.

The SNAP started 1,5h after the radon controller was placed in high radon crawl space, indicating the time needed for radon to diffuse into the diffusion chamber of the detector. The fan stopped 1h after the radon controller was removed from the high radon crawl space. When the radon controller was placed again in the crawl space, the SNAP started after 1h, and it stopped 45 minutes after removal from the crawl space. The experiment indicates that the response of the system is adequate considering the diffusion time of ambient air into and out of the detector.

A second test of the SNAP system considers the extraction in a crawl space controlled by a SNAP sensor installed in the adjoining basement (Fig. 5). The system has been adapted to pilot a centrifugal fan used in crawl space extraction. The radon concentration is monitored on the ground floor located living room above the crawn space. There is a clear and good correlation between the living room concentration and the extraction in the crawn-space, piloted by the SNAP sensor in the basement. When the extraction is mechanically interrupted during the experiment, the radon concentration both in the adjoining basement and in the living room above increase rapidly to levels around 1000 Bq/m³.

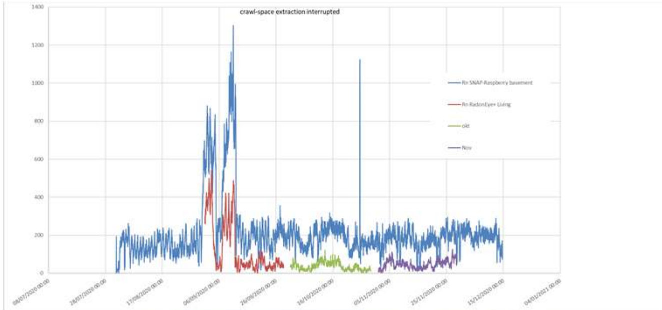

Figure 5. Crawl space extraction piloted by a SNAP sensor in the basement.

A second SNAP system has been installed in a basement with high radon concentrations and is piloted by a SNAP sensor in the living room situated above the basement (Fig. 6). It has been observed that the SNAP fan interrupts regularly, even when the radon concentration in the sensor is above the activation level of 200 Bq/m³. A second inconvenience is the instable network connection of the system. It has been observed that it disconnects regularly and without identified reason from the network, after which a complete manual setup must be carried out.

Figure 6. SNAP system installed in a basement and piloted by the SNAP sensor in the living room above.

One SNAP system has been installed in an occupied basement (workplace). The system pilots a SNAP fan installed in an external access door. It has been used to evaluate the correspondence between different radon sensors, different SNAP systems (original configuration and configuration adapted for centrifugal fans). The preliminary results indicate the possibility and flexibility to adapt the system to accommodate different configurations (living room extraction or pulsion, crawl space extraction, basement extraction or pulsion). The robustness of communication and connection of the configurations are studied during the current winter period.

3. Public awareness and dissemination of results (Action D1)

Although the covid-19 emergency has created many problems regarding the organization and the participation of people in public events, some of the LIFE-RESPIRE results were presented at virtual conferences and workshops addressed to researchers, public, local and regional authorities and building professionals.

European Radon Week 2020 (24-28 February, Vienna, Austria)

The event was divided in three Workshops:

European Radon Association (ERA) Workshop (24 February) in which the Respire consortium was invited to present the LIFE-Respire project
G. Ciotoli (CNR, Italy). The LIFE-Respire project: scope, objectives and current status;

The MetroRADON Workshop (25-26 February) in which, according to the networking agreement between MetroRADON and LIFE-Respire project, a presentation was done in within the Workpackage WP 4 -Radon priority areas and the development of the concept of a geogenic radon hazard index
G. Ciotoli (CNR, Italy) & P. Bossew (BfS, Germany). The geogenic radon hazard index;

Joint Research Centre Workshop – Technical solution for displaying and communicating indoor radon data (27-28 February)
G. Ciotoli (CNR, Italy) and P. Bossew (BfS, Germany). Spatial multivariate analyses for the mapping of the European geogenic radon potential.

Webinar MAPEI Academy (24 June 2020)
Il Radon: come progettare, proteggere ed impermeabilizzare le strutture:

G. Ciotoli (CNR-IGAG). Il potenziale geogenico di radon.
G. Ciotoli (CNR-IGAG), P. Tuccimei (ROMA TRE). Vautazione sperimentale dei livelli di radon indoor in una "scale mode room"

GEOHEALTH 2020 International Meeting of Geohealth Scientists (virtual meeting 1-2 September 2020)

Session PQ04 Radon in the environment, chaired by G. Ciotoli (CNR-IGAG), D. Cicchella (Sannio University), S. Albanese (University of Neaples)

4. Upcoming events

European Geosciences Union-General Assembly 2021 (vEGU21) (19-30 April 2021)

A session on "*Radon: geogenic sources, hazard mapping, and health risk (NH8.5)*", will be hosted to the forthcoming virtual EGU Meeting 2021 (vEGU21) (19-30 April 2021). The session will be chaired by the LIFE-Respire Consortium: S. Bigi (UNIROMA1), A. Sciarra (INGV) and G. Ciotoli (CNR-IGAG).

Workshop "Nuove tecnologie per sensori e biosensori @ Area della Ricerca di Roma 1"
Evento conclusivo progetto DESIR - Bando "Progetti di Gruppi di Ricerca" 2017 Lazio Innova

G. Ciotoli (CNR-IGAG) The LIFE-Respire project.

Publications:

Bossew P., Cinelli G., Ciotoli G., Crowley Q.G., De Cort M., Elío Medina J., Gruber V., Petermann E., Tollefsen T. (2020) Development of a Geogenic Radon Hazard Index-Concept, History, Experiences. *Int. J. Environ. Res. Public Health*, *17*(11), N. 4134, 1-24 (Open Access).

Giustini F., Ciotoli G., Rinaldini A., Ruggiero L., Voltaggio M. (2019). Mapping the geogenic radon potential and radon risk by using Empirical Bayesian Kriging regression: a case study from volcanic area of central Italy. Science of the Total Environment, STOTEN 30460, 661, 449-464

Achatz M. et alii (2019). European Atlas of Natural Radiation. Cinelli, G., De Cort, M. and Tollefsen, T. editor(s), Publications Office of the European Union, Luxembourg, 2019, JRC116795.